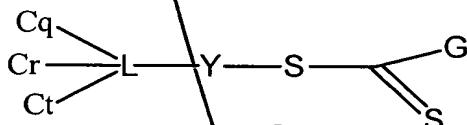


WE CLAIM:

1. A polymer brush for binding a molecule in an aqueous sample in an assay comprising:  
a substrate having a surface, and  
a layer on the substrate surface comprising polymer chains having two termini, one terminus being free and the other terminus being bound to the substrate surface, and a water-soluble or water-dispersible intermediate portion between the two termini, wherein  
(i) the terminus of each polymer chain bound to the substrate surface comprises a residue of a surface bound initiator having the formula



wherein C is a moiety on the surface of the substrate; L is a linker group capable of bonding to at least one C moiety; q, r and t are independently 0 or 1, provided the sum of q + r + t is at least 1; Y is a residue capable of initiating free radical polymerization upon homolytic cleavage of the Y-S bond; S is sulfur; and, G is a nitrogen or an oxygen heteroatom, and

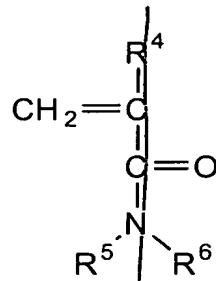
(ii) the intermediate portion of each polymer chain has a weight average molecular weight of at least about 1000, is substantially free of crosslinks to an intermediate portion of another polymer chain, contains repeat units derived from an acrylamide-based monomer and at least one other monomer, and contains functionalized sites which have been formed in their active state.

2. The polymer brush according to claim 1 wherein the intermediate portion contains repeat units derived from a monomer having the formula:

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wherein R<sup>4</sup> is H or an alkyl group, R<sup>5</sup> is methyl and R<sup>6</sup> is methyl.

3. The polymer brush according to claim 2 wherein the intermediate portion contains repeat units derived from N,N-dimethylacrylamide.

4. The polymer brush according to claim 1 further comprising spacer molecules bound to said surface, wherein the ratio of polymer chains to the sum of polymer chains and spacer molecules is about 0.75:1.

5. The polymer brush according to claim 1 wherein the density of functional sites is at least about 20 picomoles per square centimeter of substrate surface area.

6. The polymer brush according to claim 1 wherein said brush further comprises a probe.

7. A method for detecting a biological molecule in an aqueous sample comprising contacting the polymer brush of claim 6 with said sample, and thereafter analyzing said polymer brush for the presence or quantity of said biological molecule.

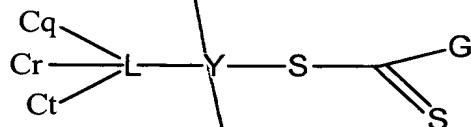
8. A sensor for detecting a biological molecule in an aqueous sample comprising:  
a substrate having a surface; and

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5 a plurality of polymer chains bound to said surface, each of said plurality of polymer chains comprising a water-soluble or water-dispersible segment and at least one probe bonded to said water-soluble or water-dispersible segment, the probe being selective for the biological molecule,

wherein said polymer chains are synthesized according to a process comprising:

- 10 (i) bonding an iniferter initiator to said surface at one or more points to form a derivatized surface, said iniferter initiator comprising an initiator-control agent adduct having the formula:



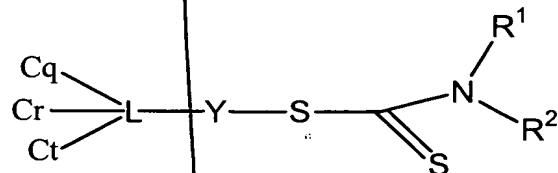
15 wherein C is a moiety on the surface of the substrate; L is a linker group capable of bonding to at least one C moiety; q, r and t are independently 0 or 1, provided the sum of q + r + t is at least 1; Y is a residue capable of initiating free radical polymerization upon homolytic cleavage of the Y-S bond; S is sulfur; and, 20 G is a nitrogen or an oxygen heteroatom;

- (ii) contacting said derivatized surface with a composition comprising a water-soluble or water-dispersible free radically polymerizable monomer mixture, the mixture containing an acrylamide-based monomer and at least 1 other monomer, and an unbound iniferter initiator under reaction conditions to form 25 bound and unbound polymer chains comprising functionalized sites on the polymer chain, the functionalized sites being formed in their active state for reaction with the probe molecule;

(iii) separating unbound polymer; and

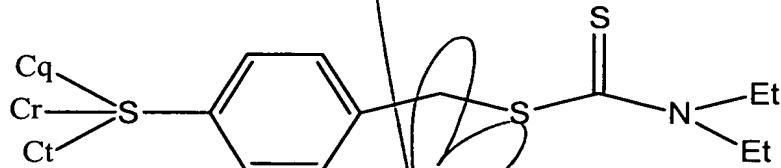
- (iv) bonding probes to the bound polymer chains through the active 30 functionalized sites.

9. The sensor according to claim 8 wherein the bound initiator comprises an initiator-control agent adduct having the formula:



5 wherein N is nitrogen, and R<sup>1</sup> and R<sup>2</sup> are independently selected from  
• hydrocarbyl and substituted hydrocarbyl.

10. The sensor according to claim 9 wherein said bound initiator comprises an initiator-control agent adduct having the formula:



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wherein Et is ethyl.

11. The sensor according to claim 10 wherein C is derived from a hydroxyl group.

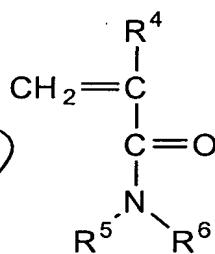
12. The sensor according to claim 10 wherein  $q = 1$ ,  $r = 1$  and  $t = 0$ .

13. The sensor according to claim 10 wherein  $q = 1$ ,  $r = 1$  and  $t = 1$ .

14. The sensor according to claim 8 further comprising spacer molecules bound to said surface at one or more points different from the points at

which said polymer chains are bound to space said polymer chains apart from each other, wherein the ratio of polymer chains to the sum of polymer chains and 5 spacer molecules is about 0.75:1.

15. The sensor according to claim 8 wherein the acrylamide-based monomer has the formula:



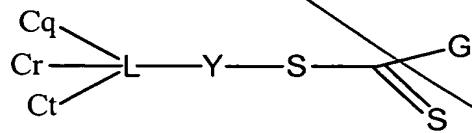
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wherein R<sup>4</sup> is H or an alkyl group, R<sup>5</sup> is methyl and R<sup>6</sup> is methyl.

16. The sensor according to claim 15 wherein the monomer is N,N-dimethylacrylamide.

17. A method of preparing a sensor for detecting a biological molecule in an aqueous sample, the method comprising:

bonding an iniferter initiator to a substrate surface at one or more points to form a derivatized surface, said iniferter initiator comprising an initiator-control 5 agent adduct having the formula:



wherein C is a moiety on the surface of the substrate; L is a linker group capable of bonding to at least one C moiety; q, r and t are independently 0 or 1,

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10 provided the sum of  $q + r + t$  is at least 1; Y is a residue capable of initiating free radical polymerization upon homolytic cleavage of the Y-S bond; S is sulfur, and, G is a nitrogen or an oxygen heteroatom;

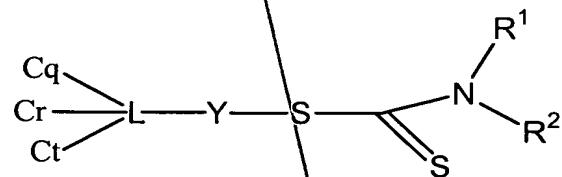
15 contacting said derivatized surface with a composition comprising a water-soluble or water-dispersible free radically polymerizable monomer mixture, the mixture containing an acrylamide-based monomer and at least 1 other monomer, under reaction conditions to form bound polymer chains comprising a water-dispersible segment having a weight average molecular weight of at least about 1000 and one or more functionalized sites thereon, the functionalized site(s) being formed in its(their) active state for reaction with a probe selective for the

20 biological molecule;

separating unbound polymer; and

bonding the probe to the bound polymer chains through the active functionalized sites.

18. The method according to claim 17 wherein the bound initiator comprises an initiator-control agent adduct having the formula:

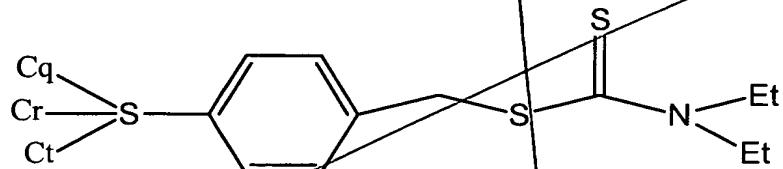


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wherein N is nitrogen, and R<sup>1</sup> and R<sup>2</sup> are independently selected from hydrocarbyl and substituted hydrocarbyl.

*Sub  
A2  
B6*

19. The method according to claim 18 wherein said bound initiator comprises an initiator-control agent adduct having the formula:



5 wherein Et is ethyl.

20. The method according to claim 19 wherein C is derived from a hydroxyl group.

21. The method according to claim 19 wherein q = 1, r = 1 and t = 0.

22. The method according to claim 19 wherein q = 1, r = 1 and t = 1.

23. The method according to claim 17 further comprising spacer molecules bound to said surface at one or more points different from the points at which said polymer chains are bound to space said polymer chains apart from each other, wherein the ratio of polymer chains to the sum of polymer chains and 5 spacer molecules is about 0.75:1.

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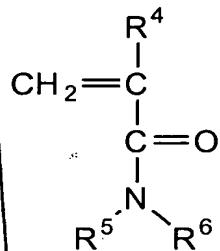
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*Sub B3*  
*Sub B4*

24. The method according to claim 17 wherein the acrylamide-based monomer has the formula:



wherein  $\text{R}^4$  is H or an alkyl group,  $\text{R}^5$  is methyl and  $\text{R}^6$  is methyl.

25. The method according to claim 24 wherein the monomer is N,N-dimethylacrylamide.

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*Sub A3*  
*Sub B4*